Cab Heating and Cooling

Evaluation Final Report
Schneider National, Inc

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Evaluation Summary

Schneider National, Inc., SNI, has concluded the Cab Heating and Cooling evaluation of onboard, engine off idling solutions. During the evaluation period three technologies were tested, a Webasto Airtronic diesel fired heater for cold weather operation, and two different approaches to cab cooling in warm weather, a Webasto Parking Cooler, phase change storage system and a Bergstrom Nite System, a 12 volt electrical air conditioning approach to cooling.

Diesel fired cab heaters were concluded to provide adequate heat in winter environments down to 10° F. With a targeted idle reduction of 17%, the payback period is under 2 years.

The Webasto Parking Cooler demonstrated the viability of this type of technology, but required significant driver involvement to achieve maximum performance. Drivers rated the technology as 'acceptable', however, in individual discussions it became apparent they were not satisfied with the system limitations in hot weather, (over 85° F).

The Bergstrom Nite system was recognized as an improvement by drivers and required less direct driver input to operate. While slightly improved over the Parking Cooler, the hot temperature limitations were only slightly better.

Neither the Parking Cooler or the Nite System showed any payback potential at the targeted 17% idle reduction. Fleets who are starting at a higher idle baseline may have a more favorable payback.

Webasto Airtronic Cab Heater

Cab heaters can provide as warm of an environment in the bunk areas as drivers can get from idling the tractor. They are easy to use, small, do not require any additional set up from the drivers and can easily maintain an interior temperature of 70° F at ambient temperatures down to 10° F. There is a risk that drivers could use the heaters below 10° F and cold soak the engine. At ambient temperatures below this a diesel engine will not start if it sits for 10 hours or more if the truck is not plugged in with an engine heater. However, the test group did not show any difference in jump starts against the control group. Drivers were well versed in following this stance.

During the winter period of operation cab heaters were effective at reducing idle times at the targeted 17% reduction. The following table shows the idle times for test and control units and the total idle reduction achieved over the two winter periods.

	Test Idle	Control Idle	Difference
November	5.921	18.743	12.822
December	8.452	18.743	10.290
January	17.451	33.598	16.146
February	9.613	27.766	18.153
March	5.770	19.740	13.970
November	8.817	21.736	12.919
December	9.764	32.868	23.104
January	16.591	37.182	20.591
February	10.165	32.574	22.409
March	8.997	26.830	17.833
Ave Reduction			16.824

The above results show an NPV payback of less than two years with fuel pricing above $2.40/gal for cab air heaters.

MPG also showed an improvement. The net increase in the test units was .158, however a portion of this improvement was evident all year long, not just in the winter. We were never able to determine why the test group had an overall positive impact throughout the summer months. A comment from one of the drivers may explain why overall results, even in summer, were more positive. He indicated that once you get used to not sleeping with the engine on you only idle when you absolutely need to. Backing this difference out the impact was .126. The table below shows the overall impact.

	Test MPG	Control MPG	Difference
November	6.742	6.678	0.064
December	6.654	6.638	0.016
January	6.453	6.231	0.221
February	6.562	6.384	0.177
March	6.780	6.645	0.135
November	6.833	6.702	0.131
December	6.677	6.311	0.366
January	6.505	6.245	0.260
February	6.690	6.580	0.110
March	6.736	6.638	0.099
MPG Improvement			0.158

Using the adjusted actual MPG gain shows a similar payback of just under two years. In the heating evaluation, the correlation between idle reduction and MPG performance was very close.

Based on early cab heater results SNI made a specification change on all tractors to put diesel fired heaters in all trucks. All trucks purchased since June of 2003 have either been retrofitted with this technology or have been factory installed. SNI currently has close to 6,000 trucks with cab heaters installed.

Webasto Parking Cooler

The cooling portion of the evaluation began with high expectations. The technology provided a way to cool the bunk area, without running the engine, and with a low energy requirement. Air conditioning the sleep area is much more difficult than heating and requires a much more complicated approach to energy use. Phase change, or cool storage, appeared to be a viable path toward reasonable energy consumption during use.

Drivers were fairly optimistic in surveys completed during the coarse of the evaluation, and rated it 4/5, in a scaled rating. This would put it in an acceptable range, however, individual conversations with drivers, as well as actual results, would indicate that we never achieved the differentiation between the test trucks and control trucks. The charts below show this.

Actual Data

	Test	Control	Difference
May	14.19	15.34	1.15
June	19.81	19.84	0.03
July	20.96	23.84	2.87
August	21.32	10.03	-11.30
September	15.38	17.85	2.46
May	11.77	19.15	7.38
June	19.94	26.26	6.32
July	25.80	34.22	8.42
August	26.40	33.19	6.79
September	24.76	27.48	2.72
Average			2.69

Data With Out of Range Removed

	Test	Control	Difference
May	6.30	15.34	9.04
June	8.61	19.84	11.23
July	9.22	23.84	14.62
August	7.46	19.67	12.21
September	7.23	17.85	10.62
May	3.38	19.15	15.77
June	9.88	26.26	16.38
July	11.39	34.22	22.83
August	4.21	33.19	28.98
September	7.25	27.48	20.23
Average			16.19

When the out of range data is removed we found the data was closer to the expected 17% reduction in idle. In discussions with Operations it was determined that drivers who had very high idle during the period had missed their bonus incentive due to other factors. Once drivers fail to achieve bonus they idled the truck. A logical assumption is this is an indication the coolers do not meet their expectations in performance. The 'Out of Range' table above shows what could be possible if all drivers used coolers consistently.

Fuel Economy was 6.91 for the test Vs 6.94 for control, not the difference expected, or enough to justify purchase. Like idle, if you remove the out of range data it provides more differentiation, but was less than expected.

When drivers were reassigned into these trucks they also did not use the units. The primary reason was they did not know how to use them. Planning the charging periods with driving time, getting maximum performance by pre-cooling the sleep area, and understanding limitations around battery capacity are not inherent to the drivers. The systems are more complex than simply turning on a switch and having them work.

The final observation from this evaluation is that drivers who reported limited capacity had high initial bunk temperatures prior to turning on the units. Not all drivers followed

instructions to pre-cool the bunk area prior to use. Drivers who pre-cooled the area, then used the system had fewer reports of capacity issues.

Berstom Nite System

This technology came to market after the initial evaluation was started. It was a different approach to cooling that was added to the summer cooling evaluation. The Bergstrom approach uses a 12 volt air conditioning system powered by a battery pack to cool the sleep area. Similar to the Parking Cooler it requires pre-cooling of the bunk prior to use. Battery capacity is significantly reduced if the system is started with high sleep area temperatures.

The system is easier to use than the Parking Cooler as you do not have to plan any charging period during driving time, although the driver needed a 6 to 8 hour driving period to fully recharge the batteries. Initial units installed had two 6 volt AGM batteries in series for the power source during rest periods, that were isolated from the tractor batteries. Batteries lasted through the two year evaluation period with no problems.

Results were very similar to the Parking Cooler. We encountered similar driver reaction when they were disqualified for their bonus; The drivers idled as an alternative to using the Nite system. Following are idle results during the evaluation period:

Actual Data:				Data With Out of Range Removed:			
	Test	Control	Difference		Test	Control	Difference
August	7.58	15.20	7.63	August	6.54	15.20	8.66
September	8.87	14.49	5.62	September	2.66	14.49	11.83
May	8.87	8.95	0.09	May	4.33	8.95	4.62
June	16.62	17.34	0.72	June	6.62	17.34	10.72
July	17.47	20.41	2.93	July	10.14	20.41	10.27
August	16.78	20.45	3.67	August	9.20	20.45	11.25
September	17.35	17.55	0.20	September	8.85	17.55	8.70
Average			2.98	Average			9.44

Drivers who consistently used the Nite system were overwhelmingly positive about it's performance. Drivers who pre-cooled the truck had significantly more capacity than those that started the system with higher internal temperatures and were much more positive about the system performance. Less driver interaction was required, drivers didn't need to pre-select a charge mode, it occurred automatically.

During the second summer of the evaluation we took two trucks and added two additional batteries. Drivers on these two trucks reported improved internal temperatures, in higher ambient temperatures and added capacity. Moving forward we would recommend using four batteries.

I had the opportunity to meet one of the drivers at a recent demonstration event. His average fuel economy was 7.5 MPG, with an idle percentage of 0.1%. He had nothing

but good things to say about the system and had very few capacity issues. He obviously had found a way to maximize the system performance.

Conclusions

1. Diesel fired air heaters are a viable, affordable alternative to winter idle. They maintain a similar temperature environment as idling, are lightweight, durable, easy to use and readily available.
2. Cab insulation is a major issues and recognized by drivers as a limiting factor in cab cooling. Many drivers in their weekly reports indicated heat migration into the sleep area through walls and floor areas. Drivers commented that while the cool air was flowing from the ducts they could feel heat from the floor and walls coming in at the same time.
3. Drivers have an expectation that the air conditioning system perform similarly to what they experience at idle. If there is an incentive to use the system the drivers will go back to idling the truck if the system is not as effective as idling is when the incentive is lost.
4. Minimizing driver interaction with the system and controls is important in obtaining the best results.
5. Less planning prior to use maximizes the chances drivers will get the full benefit of the system. When drivers need to charge the system, pre-cool the sleep area, or be aware of the state of charge of the batteries it will lesson the chance of getting optimal performance from the system.
6. Training of drivers on how to use the system is very important and needs to be followed through with a refresher at the start of each season.
7. Payback on idle reduction air conditioning technologies is an issue. Even at higher fuel prices, the systems cost considerably more than idling the truck, even at higher idle percentages.
8. During the evaluation period drivers found ways to accommodate the extra weight of the A/C system by short fueling when hauling heavy loads. Long term the additional weight of idle components needs to be addressed nationally.
9. Through the evaluation many limitations have been exposed on the air conditioning issue. Both the Parking Coolers and the Nite System have had upgrades due to feedback during this period. OEM's are starting to put more consideration into tractor insulation and are working closer with the suppliers to integrate engine off technologies into the truck. While the solutions tested are not quite up to expectations they are much further along than when the project was started.